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# Progress and Prospects in Gender Visibility at SMBE Annual Meetings

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## Abstract

Reduced visibility of women in science is thought to be one of the causes of their underrepresentation among scientists, in particular at senior positions. Visibility is achieved through publications, and through conference attendance and presentations. Here, we investigated gender differences in visibility at the annual meetings of the Society of Molecular Biology and Evolution. The analysis of meeting programs showed a regular increase in female speakers for the last 16 years. Data on abstract submission suggest that there are no gender-related preferences in the acceptance of contributed presentations at the most recent meetings. However, data collected on-site in 2015 and 2016 show that women asked only ~25% of the questions, that is, much less than expected given the female attendance. Understanding the reasons for this pattern is necessary for the development of policies that aim to reduce imbalance in visibility.

**Key words:** gender ratio, leaky pipeline, conference statistics, questions, oral communications, talk duration.

## Introduction

The gender gap in science is strong: only 29% and 32% of the researchers in STEM fields (science, technology, engineering, and mathematics) are women, worldwide and in North America and Western Europe, respectively (UNESCO Institute for Statistics 2017). This gender gap tends to increase along the research career, with, for example, in France, women representing 58% of undergraduate students, 47% of doctoral students, and only 26% of researchers (UNESCO Institute for Statistics 2017); a typical pattern found in many countries and called the “leaky pipeline” (Pell 1996; Shaw and Stanton 2012; Thomas et al. 2015; Loison et al. 2017). A multitude of factors have been shown or hypothesized to be responsible for this phenomenon. Conscious or unconscious discrimination against women by selection committees for grants, positions, and prizes is one of them (Wenneras and Wold 1997; Bornmann and Daniel 2005; Lincoln et al. 2012),

but it seems that such discrimination is strongly diminishing (discrimination might even be positive, cf. Williams and Ceci 2015). Other factors may include gender differences in self-esteem: men might be more convinced of their own excellence than women (Reuben et al. 2014; but see Laurance et al. 2011) whereas women might attribute their success more often to external factors (Clance and Imes 1978). Female students might also be influenced by the lack of successful female role models, and by a pervasive cultural association linking men but not women to abstract reasoning, and thus conclude that a scientific career is not for them (Reuben et al. 2014; Leslie et al. 2015; Masur 2015). Such a belief is strengthened by underrecognition and even denial of the contributions made by women in STEM fields (Rossiter 1993; Lincoln et al. 2012). Last but not least, in many countries women have the larger share in domestic tasks and childcare,

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making it difficult for them to be as productive and visible as men (Ceci et al. 2014; Loison et al. 2017).

The “visibility” of a scientist in the scientific community is important for his or her career (Damschen et al. 2005; Thelwall et al. 2006; Schroeder et al. 2013; Johnson et al. 2017). This visibility is achieved through written publications, grant success, and also conference attendance, presentations, plenary talks, and engagement with the media. Conferences offer an opportunity for speakers to affirm their scientific leadership by putting their results in the spotlight. In addition, they are an important occasion for participants to enhance their professional network and discuss job opportunities. Thus, if women are less visible at conferences, this could negatively influence the diffusion of their work, and in turn result in fewer citations, more difficulties in having future projects funded, and fewer opportunities to find new job positions (for early-stage researchers) or to attract candidates for open positions in their research groups or departments (for advanced researchers). Previous work on scientific conferences has shown that women were underrepresented among the speakers (Schroeder et al. 2013; Casadevall and Handelsman 2014; Johnson et al. 2017; Débarre et al., forthcoming).

The Society of Molecular Biology and Evolution (SMBE) has been concerned with offering equal chances to women and men, by establishing, in the last decade, a visible policy of gender balance among invited speakers, the editorial board and council, and by offering options for childcare during their annual conferences. We here studied gender differences in visibility at the SMBE annual meetings. We looked at the gender ratio for oral communications and posters in the last 16 years, and selection bias for oral communication in 2010, 2015, and 2016. In addition to studying visibility through presentations, we also studied it at the question sessions following the oral communications, an aspect of visibility that has started to be investigated only very recently (Carter et al. 2017; Hinsley et al. 2017).

## An Increasing Proportion of Women among Presenters from 2001 to 2017

We measured gender bias in the presentations of several SMBE conferences from 2001 to 2017. In all years, men are overrepresented in all types of presentations, but this overrepresentation is decreasing, although more slowly for invited speakers (the category of invited speakers includes the keynote speakers; readers not familiar with SMBE conferences will find a short description in the Materials and Methods section) and postgraduate scientists than for speakers giving contributed talks (including the plenary Walter Fitch talks) and undergraduate scientists (fig. 1). In the last 2 years, the proportion of women among the poster presenters decreased slightly; this could be an effect of the geographic location, but we have insufficient data to investigate this trend. Overall, we did not find any significant differences in the gender bias

between speakers of the two largest continents represented at these conferences, North America and Europe (two-sided Fisher's exact tests: 2001,  $P = 0.29$ ; 2003,  $P = 0.29$ ; 2007,  $P = 1$ ; 2010,  $P = 0.45$ ; 2015,  $P = 0.47$ ; 2016,  $P = 0.17$ ; 2017,  $P = 0.89$ ; cf. [supplementary fig. 1B, Supplementary Material online](#)).

Figure 1 also shows a brief chronology of the SMBE policies in favor of gender equity. During the last decade, organizers of annual meetings received a memo asking them to take gender into account while selecting presenters. A special effort was made by the organizer of the 2003 conference (B. Gaut), who dedicated a session to gender equity. On-site childcare was proposed first in 2010 and has become a rule since then. In 2015, the SMBE started to provide support for any person that would care for the participant's children during the conference (“childcare awards”). For the most recent SMBE annual meetings, the publicly available guidelines for the organizers indicate that gender balance should be promoted at every step of the organization (organizing symposia, selecting speakers, providing travel awards; SMBE 2017). Importantly, these guidelines ask that registration includes a declaration of gender, and that statistics on gender balance are reported after the meeting. Our results suggest that the repeated and cumulated efforts to promote gender equity are successful in gradually decreasing gender imbalance.

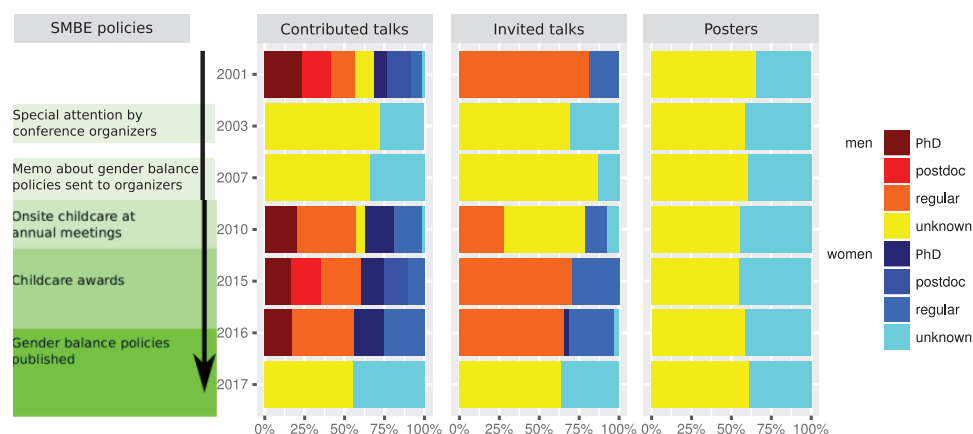
## Unbiased Selection of Oral Communications

For the conferences in 2010 (Lyon, France), 2015 (Vienna, Austria), and 2016 (Gold Coast, Australia), we had access to the full participant list and all submissions. The gender ratio of the participants at these conferences was similar, with no significant bias for students, and a significant male bias ( $> 60\%$  men) for postgraduate researchers (fig. 2 and [supplementary table 1, Supplementary Material online](#)).

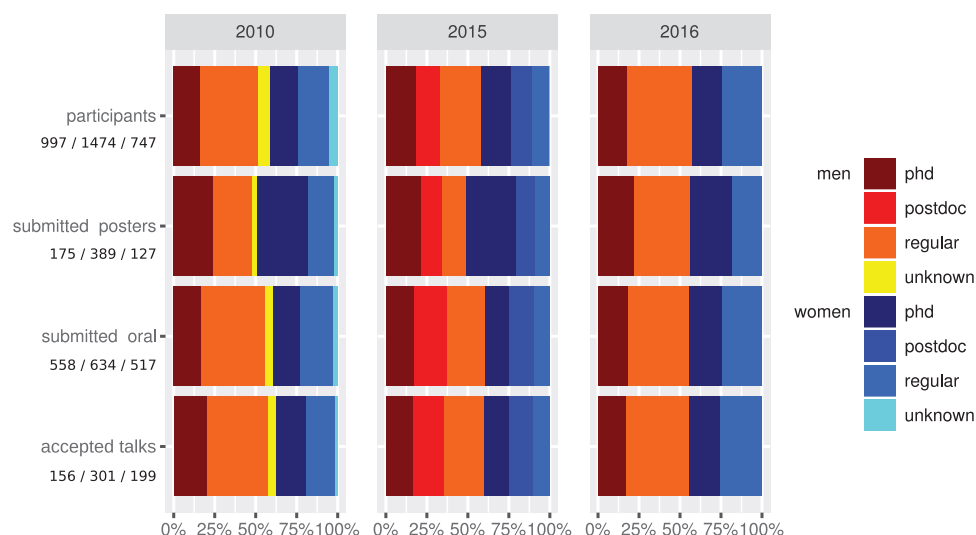
An oral presentation typically reaches a wider audience than a poster presentation. We first asked whether there was any difference between men and women for the type of presentation that they applied for (fig. 2 and [supplementary table 2, Supplementary Material online](#)). No significant difference was detected once we took the status of the applicants into account: students less often apply for oral presentations than postgraduate researchers, irrespective of their gender. Furthermore, the gender ratio of the speakers of the accepted talks did not differ significantly from the gender ratio of the applications. Thus, no discrimination of women, neither negative nor positive, seems to have occurred in the selection of oral presentations in the three conferences we analyzed.

## No Differences in Talk Duration

In 2015 and 2016, groups of five to six volunteers collected statistics on the oral presentations. Men and women might



**FIG. 1.**—Evolution of the gender bias in oral (contributed and invited) and poster presentations in all analyzed conferences (2001–2017). The leftmost panel indicates the actions taken to promote gender balance at annual meetings.



**FIG. 2.**—Gender ratio of participants, submissions, and selection per registration category for the conferences in 2010, 2015, and 2016. Corresponding statistical tests are in [supplementary tables 1 and 2, Supplementary Material](#) online. For each category, total counts for each of the 3 years are given.

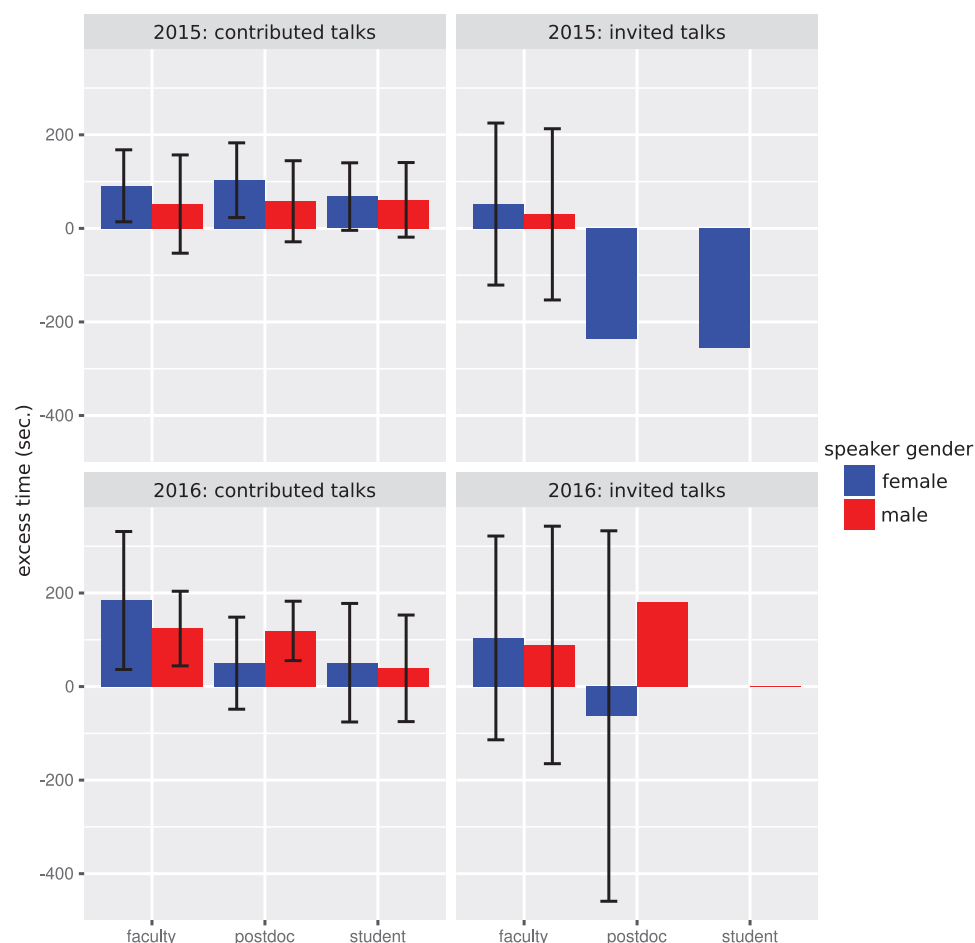
differ in conversational styles, with women putting a greater effort in “conversational work,” that is, facilitating the dialogue by leaving silences, and letting others speak, whereas men more often interrupt and pay less attention to their partner’s speech (Fishman 1978; Hancock and Rubin 2015). We hypothesized that such behavior, if it exists at conferences, would imply that women leave more time for questions than men, which could lead to women’s presentations receiving less exposure than men’s presentations.

Contributed talks were given in slots of 15 min, and the organizers instructed the speakers to leave 3 min for questions; invited speakers had slots of 30 min, of which 5 min were dedicated to questions. In the large majority of cases, the talk extended into the time available for questions (fig. 3). We performed analyses of variance (ANOVAs) of the difference between the allotted time and the real duration of the talks, taking the talk type and the status (PhD-student,

postdoctoral researcher, or faculty) of the speaker into account. The only significant effects that we found were related to the talk type and the status of the speakers, not their gender ([supplementary table 3, Supplementary Material](#) online). In 2015, contributed talks tended to extend more into the time reserved for questions than invited talks, and the few (2) invited talks given by students and postdocs were particularly short; in 2016, the main effect on talk length was the academic status of the speaker, with students and postdocs stopping earlier than faculty members.

### More Questions Were Asked by Men than by Women

The volunteers also recorded the gender of the participants that publicly asked questions after the talk. Strikingly, in both 2015 and 2016, less than one-third of the questions were



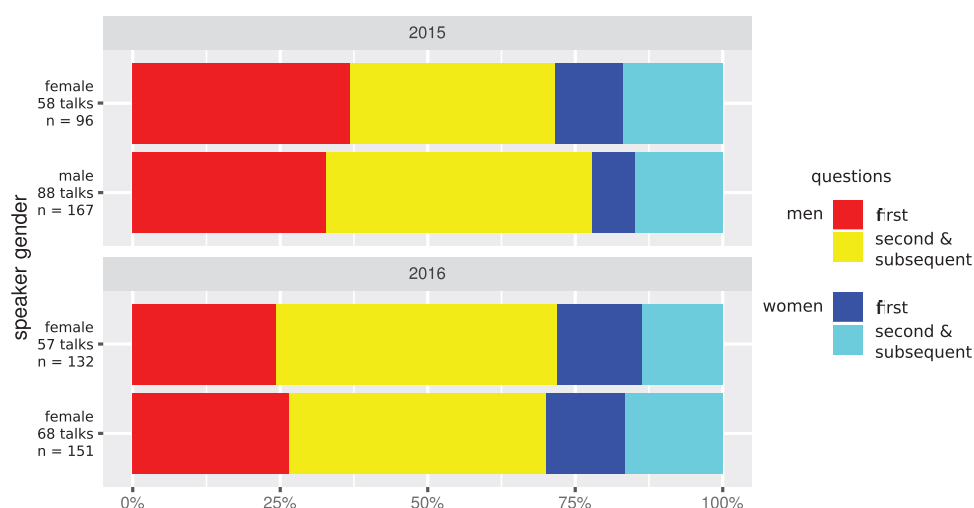
**FIG. 3.**—Average difference between the allotted time and the real talk duration. Excess time is plotted in seconds, thus positive values indicated that the real time exceeded the allotted time. Error bars represent the standard errors; when error bars are missing, only one observation was available. For statistically significant differences, see [supplementary table 3, Supplementary Material](#) online.

asked by women (in 2015, 62 questions were asked by women and 199 by men, and in 2016, 83 by women and 201 by men; see [fig. 4](#)). In both 2015 and 2016, there were more male than female participants, and thus more questions from men are expected. However, even after correcting for this trivial effect, women were significantly underrepresented among those who asked questions (Fisher's exact test  $P = 2.9 \times 10^{-8}$  for 2015,  $P = 1.1 \times 10^{-3}$  for 2016).

It is not clear to what degree this imbalance can be explained by a higher proportion of men among senior scientists, who are thought to ask more questions. Estimates for the proportion of men among full professors in biology are 75–78% ([Schroeder et al. 2013](#); [Nittroter et al. 2018](#)). If this proportion were to explain the entire gender imbalance observed among those who ask questions (averaged over 2015 and 2016, 73.5% of all questions came from men), this would imply that the vast majority of the questions were asked by full professors. Because the proportion of men increases gradually along career stages, and along with it

most likely the propensity to ask questions, a fine scale age-structured analysis would be necessary to reach firmer conclusions.

Further analysis of our data revealed that the gender of the speaker did not influence the number of questions, nor the gender bias among those who asked questions ([fig. 4](#)): in 2015, men received on an average 1.9 questions and women 1.7 (two-sided  $t$ -test:  $P = 0.24$ ; Wilcoxon signed rank test:  $P = 0.48$ ); in 2016, men received on an average 2.2 questions and women 2.3 (two-sided  $t$ -test:  $P = 0.37$ ; Wilcoxon signed rank test:  $P = 0.32$ ). We found that the overrepresentation of men is similar among those who ask the first question after each presentation and among those who ask subsequent questions ([fig. 4](#); Fisher's exact test  $P = 0.24$  for 2015,  $P = 0.062$  for 2016). Finally, an ANOVA on the gender ratio of the questioners did not reveal any significant effect of the gender of the speaker, their academic position, nor the type of talk ([supplementary table 4, Supplementary Material](#) online).



**Fig. 4.**—Questions from male and female participants to male and female speakers. The number of male and female speakers whose presentations were used for data collection are given at the left side of the figure, as well as the total number of questions counted (*n*).

## Discussion

### Gender Differences in Visibility through Presentations

Gender balance in oral presentations at SMBE conferences has gradually improved since 2001, in agreement with what has been observed for other conferences (Schroeder et al. 2013; Casadevall and Handelsman 2014; Arnold 2015; Johnson et al. 2017; Débarre et al., forthcoming). The continuity of actions taken by SMBE to promote gender equity has likely contributed to the steady progress. Beyond the small number of families that have asked for on-site childcare or childcare awards, the general changes in policies probably help women to feel more welcomed and supported in their career. Similarly, at conferences of the European Society for Evolutionary Biology (ESEB), the publication of the study of Schroeder et al. (2013) and the actions it triggered to increase the proportion of women among invited speakers greatly improved gender balance (Débarre et al., forthcoming).

Our results suggest the absence of gender-related biases in the submission and selection of oral presentations in recent years (2010, 2015, and 2016): neither self-selection (i.e., the choice of the type of presentation to apply for), nor discrimination by the organizers. The gender ratio of participants who submitted abstracts was close to the overall gender ratio of participants, and close to the gender ratios observed for members of other societies in the field of evolutionary biology (Débarre et al., forthcoming); it thus seems women and men are equally likely to submit abstracts. It must however be noted that both the participants of international conferences and the members of scientific societies might have an overrepresentation of men compared with the overall academic population: men, for various reasons (e.g., smaller share of domestic tasks and parental care than women), might more often attend

international conferences, and might therefore register as members of the organizing societies.

The percentage of women among invited speakers is lower than among speakers selected from submitted abstracts. We did not investigate how invited speakers were selected, but as they include fewer students and postdocs than speakers of contributed talks, a higher percentage of men in the absence of a selection bias is expected. However, one should not conclude too quickly that all is well here. Two previous studies found that women preferred shorter talks than men (Jones et al. 2014), and that women were more likely to decline invitations (Schroeder et al. 2013), leading to less visibility of their research. Efforts to incite conference and symposium organizers to invite women, and to facilitate women to attend conferences, should therefore continue or be enlarged (cf. Martin 2014; Masur 2015; Sardelis et al. 2017).

### Gender Differences in Visibility through Questions

The observations at the conferences in 2015 and 2016 did not reveal any difference between men and women as speakers (talk length, number of questions received). However, more questions were asked by men than by women. Whether this indicates that men have a tendency to ask more questions than women is not directly clear. An obvious alternative explanation is that senior scientists, among which the proportion of men is greater, ask more questions, irrespective of gender.

Ideally, we should have recorded the academic status (PhD student, associate professor, and research fellow) of the people asking questions or estimate their age as a proxy for academic status, and compare it to the overall composition of the participant population. Such a comparison could be performed at smaller conferences, where the observers might know all the participants (Vignat, Villain, Fernandez, in



prep.). An alternative would be to invite questioners to declare their academic status before asking a question. However, this could possibly influence the gender (im)balance among the questioners. In addition, this would have modified the normal course of the conference, have required the cooperation of all session chairs, and have demanded a larger effort from the volunteers that gathered the data. As our protocol was designed to minimally impact the conference for organizers, participants, and volunteers, we did not attempt to gather such information.

Very recently, other studies on gender balance among people asking questions have been published. Hinsley et al. (2017) collected data on questions during an international conservation biology conference, and divided people who ask questions in two categories, below and above 50 years. They concluded that for the category under 50, men ask 1.8 times more questions than women. However, the population of participants under 50 is heterogeneous in status—from PhD students and postdocs with an approximately balanced gender ratio, to group leaders and department directors that are mostly men. Carter et al. (2017), who studied departmental seminars (mainly in biology and psychology), also found an overrepresentation of men among those who ask questions. Furthermore, men and women self-reported different attitudes when asking questions, even within the same categories of faculty members. In contrast to our results, Carter et al. (2017) found that the gender of the person asking the first question was positively correlated with the gender imbalance of subsequent questions. It is not clear whether this difference is related to different contexts (seminars vs. conferences) and/or fields.

Another initiative to gather statistics on the gender of people asking questions was taken by Moore-Cantwell (2017), who published an analysis of a small conference (138 participants in 2017) as a blog post. The number of men and women was almost equal, and the number of questions from men and women as well, despite the fact that many more hands were raised to ask questions by men than by women. At the same conference in 2016, however, men asked more questions than women. These observations thus raise further questions on the differences in behavior of women and men, and the possible effect of documenting them. These recent initiatives (Carter et al. 2017; Hinsley et al. 2017; Moore-Cantwell 2017), together with our study, begin to sketch an inventory of gender-related differences in asking questions after scientific oral presentations. We should thus think about the generality and the causes of this pattern, and try to understand the observed differences.

Documenting gender differences in visibility is an important step toward gender equity. Making gender imbalance visible has an important role in raising awareness (cf. Débarre et al., forthcoming), and further actions should be based on such measurements (Martin 2014; Arnold 2015). The SMBE conference guidelines (SMBE 2017) already ask that gender of the participants be recorded (but also stress that an option for

nongender conforming participants should be available, and that participants should not be obliged to provide this information). We here show that with a minimal protocol, important additional data can be gathered during conferences. Such a protocol can be applied at any conference by anyone, and such data collection offers opportunities for discussing gender imbalance with colleagues. However, by focusing on data that can be easily quantified, we miss many more subtle or qualitative differences that could exist between women and men. These considerations thus call for more research, particularly with input from the social sciences, to understand the underlying causes of gender imbalance and to be able to offer other, perhaps more efficient, actions.

## Materials and Methods

The Society for Molecular Biology and Evolution (SMBE) organizes international annual meetings that bring together several hundreds of scientists working in the field of molecular evolution. The annual meetings are constituted of oral and poster presentations. In recent years, as the conferences have grown in size, almost all presentations took place in parallel sessions (up to five), and these sessions were synchronized to allow participants to switch from one session to another. Speakers of plenary keynote presentations and longer symposia talks are invited. Other presentations are selected from submitted abstracts, and take place either in the symposia (contributed talks), or in a plenary session during which young investigators compete for the prestigious Walter Fitch prize. Visibility of the presentations thus differs depending on the type of the presentation (posters or oral presentations), the audience (plenary or parallel sessions), and the duration (keynote, invited, or contributed talks).

We collected data for 8 SMBE conferences: 2001 (Athens, USA), 2003 (Newport Beach, USA), 2007 (Halifax, Canada), 2010 (Lyon, France), 2015 (Vienna, Austria), 2016 (Gold Coast, Australia), 2017 (Austin, USA). With the growth of the size of the conferences, the oral presentations have become highly selective, as is illustrated by the rapid increase in the number of posters (supplementary fig. 1A, Supplementary Material online). Among the speakers, there is an overrepresentation of “local” scientists (i.e., coming from the continent where the conference is held; supplementary fig. 1B, Supplementary Material online).

For 2001, 2003, 2007, and 2017, we gathered data from the publicly available programs. We extracted, from hard copies available to us (2001–2007) or from the electronically published program (2017): the country where research was conducted (based on the speaker’s location), the speaker’s status (available only in 2001) as well as the type of talk (keynote, invited, contributed, and Walter Fitch). We inferred the gender of the speakers from their first names when possible, or else by conducting internet search with full names and keywords. For posters, we counted the number and inferred

the gender only from first names resulting in a larger proportion of missing data.

Complete participant lists and abstract submission lists were available for the conferences in 2010, 2015, and 2016. Because of differences in the registration system, data were pretreated differently before analysis. In 2015 and 2016, gender was reported by the participants upon registration, while in 2010, gender had to be inferred, either from the title (Mr./Mrs./Ms.) or from first names (for those using titles such as Dr. or Prof., or no title), resulting in a higher percentage of participants whose gender was unknown in 2010. Academic status was inferred from the registration category; here again differences between the conferences exist. In 2010, three categories existed: invited speakers, students, and regular participants; participants registered as invited speakers were considered of unknown academic status (but some invited speakers registered as regular participants). In 2015, besides students and regular members, a separate registration category existed for postdocs.

Abstract submitters either chose for a poster presentation or an oral presentation, or both. Multiple submissions by the same person were possible. As submitters for oral presentations that were not accepted were automatically given the possibility to present a poster, we chose to distinguish between participants that exclusively applied for a poster presentation and all other submitters, whose application thus included an abstract for a possible oral presentation. Lists of accepted oral presentations and invited presentations were available. For both abstract submitters and presenters of oral presentations, academic status, and gender was inferred by matching names from submitters to names in the participant lists.

In 2015 and 2016, we recruited teams of volunteers among colleagues prior to the conference. For the talks they chose to attend, the volunteers were asked to record the name and apparent gender of the speaker (female, male, or unknown) the number of questions by men and women, the order of questions, and if possible the duration of the talks and of the total time slot. The volunteers also recorded the gender of the session's chairpersons, but as many sessions had multiple chairpersons, and the role of each of them was not always clear, we chose to discard this information. In both years, participants wishing to ask a question had to use fixed microphones, which implied they left their seat.

The academic status of the speaker was checked using internet searches. When multiple observers recorded data on the same talk, the data were checked for errors (none found), and average duration were calculated. The conference participants were not informed of this data collection. In total, the volunteers recorded data for 144 presentations in 2015 and 125 in 2016; of these, the talk duration was also recorded for 109 and 118 presentations, respectively. Duration of the keynote lectures were not used in further

analyses, as they had a less strict format, and the time for questions was left to the appreciation of the speaker.

All statistical analyses were performed with the statistical package R (R Development Core Team 2011). All reported *P* values are calculated using two-sided tests.

## Supplementary Material

Supplementary data are available at *Genome Biology and Evolution* online.

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## Author Contributions

A.S.V., C.V., and M.F. initiated the study on the analysis of question sessions; J.K., M.F., A.S.V., C.V., and G.A.B.M. elaborated the observation protocol; M.I.T. proposed the historical analysis; J.K., M.I.T., A.B., and G.A.B.M. collected data; J.K. performed data analysis; J.K., M.I.T., and G.A.B.M. drafted the manuscript.

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